

TABLE OF CONTENTS

Abstract	1
I. ORGANIZATIONAL DESCRIPTION	2
1.1 Southern University and A & M College in Baton Rouge (SUBR)	2
1.2 The Timbuktu Academy	2
1.3 Program Components	3
1.4 The Paradigm of the Timbuktu Academy & Annotations	4
1.5 Application: A Roadmap for Replicating the Timbuktu Academy & References	6
II. LIST OF ACTIVITIES BEARING ON MENTORING	8
2.1 Financial Support	8
2.2 Communication Skills Enhancement	9
2.3 Comprehensive, Scientific Advisement	9
2.4 Tutoring	9
2.5 Generic Research Activities	9
2.6 Specific Research Project Execution	10
2.7 Development of or Immersion in a Professional Culture (seminars, conferences)	10
2.8 Development or Enhancement of Computer and Technological Skills	11
2.9 Monitoring	11
2.10 Guidance to Graduate School	11
III. SUSTAINED ACHIEVEMENTS OF THE TIMBUKTU ACADEMY IN MENTORING AND RELATED ACTIVITIES	13
3.1 Summary on Graduates/Scholars and Other Achievements	13
A. Production of Master's Degree Holders in Physics: Titles of Theses, Names of Graduate students, and Graduation Dates	
B. Production of BS Degree Holders (Physics, Chemistry, and Engineering) Who Attend and Succeed in Graduate School (106 graduates as of July 2001)	
C. African American SMET Graduates Mentored in the Timbuktu Academy and Numbers Who Completed or Are in Graduate School	
D. Production of Pre-College Scholars (Who Enroll Mostly in College SMET Curricula): Over 800 from 1996 to 2000	
E. Production of National Achievement/National Merit Scholars: 10 in 1999 and 10 in 2000	
3.2 Other Accomplishments	15
A. Production and Dissemination of New Knowledge on Mentoring	
B. Selected Publications on Teaching, Mentoring, and Learning (TML)	
C. Delivery of Educational Services to the Pre-College Communities and Others: Over 5000 individuals reached per year	
D. Development SMET Infrastructure and Related Results: Increased Numbers and Quality of Undergraduate Scholars; Institutional and State-Wide Replication through LS-LAMP, Linkages to Research Laboratories	
C. External Recognition	
IV. APPENDIX	20

THE TIMBUKTU ACADEMY

"Luck is what happens when preparation meets or makes, recognizes, and acts on opportunity"

Southern University and A&M College in Baton Rouge (SUBR) proposes to disseminate to the nation the paradigm, programs, activities, and results of the Timbuktu Academy. In doing so, SUBR is hoping to stimulate or enable the replication of this program that has placed the creation of educational, research, and professional value-added, i.e., systemic mentoring, on a rigorous scientific basis. Publications identified in this proposal and the program description provide a *roadmap for replication* at home, at school, in an academic department, in graduate school, and beyond. The Timbuktu Academy mentors over sixty (60) undergraduate. As of fall 2000, ninety eight (98) minority undergraduate scholars of the Academy have earned a Bachelor of Science or of Engineering degree. Forty four (44) of 58 physics, nine (9) of 18 chemistry, and seven (7) of 22 engineering graduates have earned graduate degrees or are successfully enrolled in graduate school, with emphasis on the pursuit of the Ph.D. *As per the graduation clearance records to date, the total numbers of graduates will be 106 in July 2001, with 68 pursuing or having earned graduate degrees.* Every year, the Academy enrolls and mentors 120 to 180 pre-college students in its summer programs described below. From 1996 to present, the Academy directly mentored over 800 pre-college students who have excelled or are excelling in college preparatory curricula. It has been reaching over 5,000 students, counselors, teachers, parents, and others per year, from 1993 to present. The Timbuktu Academy has closed the academic achievement gap, as per American College Test (ACT) or Scholastic Achievement Test (SAT) scores, between its African American scholars and any other group of students, including White and Asian Americans. *The production of ten (10) National Achievement or National Merit scholars in each of 1999 and 2000 illustrates this assertion.* The long-standing educational services of the Timbuktu Academy reach new heights, last year, with the production, dissemination, and TV showing throughout the Louisiana of *"The Genesis of Genius."* This one-hour video and many other publications and presentations of the Academy explain to parents, teachers, professors, administrators, and to students how to cultivate intellectual excellence—irrespective of socioeconomic background, ethnicity, or gender. This conclusion is based on the law of performance of cognitive science which state (Education, vol. 115, No. 1, Page 31-39, 1994) that an individual's proficiency or expertise in any area increases with the number of time the person practices proper challenging tasks. This law supports or paraphrases the Jaime Escalante equation that "determination plus discipline plus hard work equal success."



ORGANIZATIONAL DESCRIPTION

The description of the Timbuktu Academy at Southern University and A&M College in Baton Rouge (SUBR) is unusual in the sense that its organizational structure, programs, and systemic mentoring activities are directly and rigorously keyed to a paradigm. Consequently, a thorough grasp of the Academy requires an understanding of the paradigm that guided the design of the program components and of the activities in each one of them. We briefly present Southern University and A&M College in Baton Rouge, the program component of the Timbuktu Academy, and the paradigm that undergirds the entire design and operation of the Academy.

Southern University and A&M College in Baton Rouge (SUBR) is a Historically Black College and University (HBCU) whose mission includes quality instruction, research, and service. The University comprises nine (9) colleges and schools, including the SMET Colleges of Sciences, of Engineering, and of Agriculture, Family, and Consumer Sciences. The total enrollment, over the last five years, was between 9,300 and 10,000 students. The College of Sciences comprises nine departments, among which we have Biology, Chemistry, Computer Science, Physics, Mathematics, Sociology, Social Work, and others. Except for Social Work, the listed departments offer the Bachelor and Master's of Science degrees. The natural science departments participate in the Ph.D. Degree Program in Science and Mathematics Education (SMED). This new program enrolled its first graduate students in the spring of 1999. The College of Engineering has three departments, i.e., of Civil, Electrical, and Mechanical Engineering.

The Timbuktu Academy is an institution-wide, systemic mentoring program that was formally established in 1990-91, based in part on the successful individual mentoring efforts of its first director, Dr. Diola Bagayoko. The Academy was first restricted to mentoring undergraduate physics majors. It was initially funded by the Louisiana Board of Regents and by the National Science Foundation (i.e., NSF- Research Careers for Minority Scholars Program-RCMS). Following a major funding by the Department of the Navy, Office of Naval Research (ONR), the Academy was expanded to include program components and systemic mentoring activities for middle school through high school students and for over fifty (50) undergraduate SEM majors per year. The expansion also included the delivery of extensive services to the educational and other communities. Starting in 1996, the graduate student mentoring component was established with funding from the Louisiana Board of Regents. The listing below shows the current subprograms of the Academy, *along with the pertinent numbers of affected scholars (from elementary school through graduate school)*.

A description of the Timbuktu Academy cannot be complete without a thorough review of (a) its paradigm that embodies a current sum of knowledge in mentoring and learning and places the systemic mentoring on a rigorous, scientific basis (i.e., the law of performance, the synthesis of cognitivism and behaviorism, etc.); the Academy's publications add to the knowledge base; and (b) the standard-based, and competitive content of its activities, including the academic enrichment, systemic mentoring, and related activities; *by virtue of the rigorous adherence of its activities to its empirically established paradigm, the Timbuktu Academy produces academic and behavioral excellence by design.*

PROGRAM COMPONENTS

THE TIMBUKTU ACADEMY

- **Getting Smart at the Timbuktu Academy (GeSTA): 20 elementary school students per summer**

The goals of GeSTA consist of increasing, in both quantitative and qualitative terms, the preparation of students for college SMET curricula. GeSTA enrolls twenty (20) elementary school students in a six (6) (3) week, non-residential, academic, summer enrichment program on the campus of Southern University and A & M College – Baton Rouge (SUBR).

- **Summer Science Institute – Middle School Component (SSI-M): 60 pre-college students per summer**

The goals of SSI-M consist of increasing, in both quantitative and qualitative terms, the preparation of students college SMET curricula. The program enrolls two groups of thirty (30) middle school students in a three (3) week, non-residential, academic, summer enrichment program on the campus of Southern University and A & M College SUBR).

- **Summer Enrichment at the Timbuktu Academy (SETA): 20 pre-college students per summer**

The goals of SETA are similar to those of SSI-M. However, SETA addresses the preparation of 9th grade students for college SMET curricula by bridging the transition from middle school to high school. The program enrolls twenty (20) ninth grade students in a six- (6) week, non-residential, science, mathematics (algebra and geometry), and English enrichment program on the campus of Southern University and A & M College – Baton Rouge (SUBR).

- **Summer Science Institute (SSI): 20 high school students per summer**

The Summer Science Institute (SSI) is a six-week, residential, intensive, academic enrichment program for twenty (20) rising pre-college seniors that emphasizes science, mathematics, and English. The overall goal of the program is to increase the pool of qualified, well-trained minority and non-minority scientists and engineers. The program encourages participants to take college preparatory courses in science, mathematics, and English.

- **Challenge 2000 (Challenge) and Earth Science at the Timbuktu Academy (ESTA): 40 HS students**

Challenge 2000 is a six- (6) week residential, pre-college, academic enrichment program similar in every respect to SSI, except that the participants are from diverse grade levels (10th – 12th grades) and have diverse levels of academic preparedness. This design simulates the reality in some high school classes. Started in the summer of 1997, Challenge 2000 enrolls twenty (20) students per summer. *ESTAs was initiated in the summer of 1999, pursuant to funding from NASA. Its characteristics are the same as those of Challenge 2000, except for the required exposure of the twenty (20) participants to Earth Science research and careers.*

- **Summer Bridge Institute (SBI): 20 college freshmen per summer**

SBI is an early college enrollment program for *high achieving* high school graduates who pledge to major in one of the disciplinary areas covered by SEM-Timbuktu Academy (i.e., engineering, physics, chemistry, computer science, mathematics). The enrollment of SBI, per summer, is twenty (20) scholars. (*The application form is available on the web.*)

- **Undergraduate Research Program (URP) and GREAT: 50+ undergraduates & (3-5) graduate students per academic year**

URP is a support, monitoring, mentoring, and research participation program for high achieving undergraduate students majoring in physics, engineering, chemistry, computer science, and mathematics. A college GPA of 3.0 or above, participation in research (academic year and summer), and GRE preparation are some essential conditions for continuing support from one year to another. Fifty (50) ONR supported scholars are involved in this subprogram in a given academic year. So are ten (10) NASA-supported scholars and some NSF-AMP scholars. The Louisiana Board of Regents funds **the Graduate Research Excellence at the Timbuktu Academy (GREAT) program.**

- **Educational Services Program (ESP): to over 5000 students, teachers, parents and others per year**

ESP is an extensive outreach program that entails the production of new knowledge, publications, and presentations (at conferences, schools, laboratories, etc.). These outreach services also include ACT/SAT preparation workshops; career

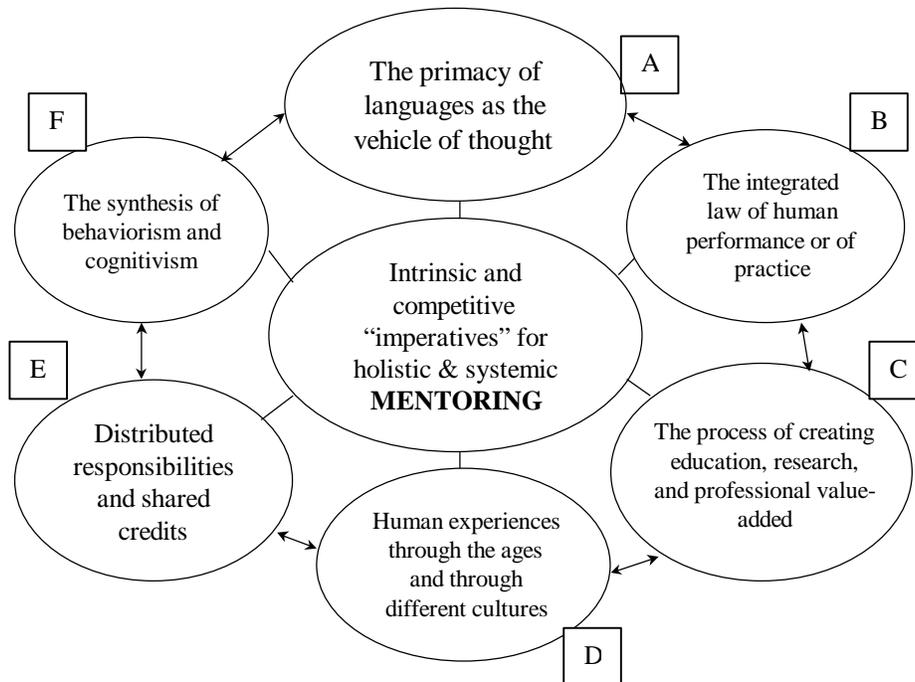
awareness in science, engineering, and mathematics disciplines; and *Saturday Learning Olympiads*.

THE PARADIGM OF THE TIMBUKTU ACADEMY

A Science for creating educational, research, and professional value-added A Roadmap for Replication

In complex processes, including research, education, and their coupling--systemic mentoring--more than good will is often required. Hence, the Timbuktu Academy was built on a paradigm to which its programs and activities adhere very strictly. As such, the Academy claims to have placed the creation of educational, research, and professional value-added on a rigorous scientific basis. A sum or a convolution of current knowledge, in several applicable disciplines, was necessary for the genesis of this comprehensive paradigm. *The scientific basis for high expectations for all students and for the ubiquitous need for systemic mentoring is rooted in the following principles or categories whose dynamic sum constitutes the paradigm of the Timbuktu Academy. Annotations of the diagrammatic representation of the paradigm, as given below, follow on the next page.*

THE PARADIGM OF THE TIMBUKTU ACADEMY



For **A** and **B**, please see References 1, 3, 4, and 7 in the annotations for the diagram.
For **C**, please see References 6 and 8.
For **D**, please refer to human experiences through the ages, including the mode of learning before the inception of formal schooling (i.e., apprenticeship or mentoring) and your own formal and informal learning experiences.
For **E**, please refer to References 1, 3, 4, and 7.
For **F**, please refer to Reference 5. F is a relatively new addition to the evolving paradigm that has to keep pace with the advances of our knowledge base.
“Luck is what happens when preparation meets or makes, recognizes, and acts on opportunity.”

ANNOTATIONS

(OF THE DIAGRAM OF THE PARADIGM)

A. The Primacy of languages as vehicles of thought.

This principle underscores the fact that science, mathematics, engineering, and technology (SMET) are done in a language. The learning, research, writing, reporting, and the related transmission to future generations require a language. Hence, the mastery of the application language is critically needed for SMET training and professional development.

B. The integrated law of human performance or of practice.

A known special case of this law, as applied to specific sensory-motor (athletic), artistic (creative), or intellectual (cognitive) tasks, simply shows -- with an empirical power law formula-- that the time T it takes for an individual to perform a task decreases as the number of times that individual practiced that task increases. Please see Reference 4 (or 1, 3, 7) for the formula. The key point here is that this implacable law applies whether we like it or not. (Our research, mentoring, curriculum reforms, presentations, improve with practice!) The integration, composition, or convolution of this "power law" for several tasks and over several years explains most of the training (or lack thereof) of any given individual, genes notwithstanding!) The integrated law of human performance provides a rigorous scientific basis for HIGH EXPECTATIONS for all students. *Yes, ability (or aptitude) itself, not just the results, is enhanced through quality practice.* Also note, as suggested by educational reforms, that the thinking "skills" or rational powers engaged by the teaching or mentoring processes, and hence practiced, are the ones that will surely be developed.

C. The process of creating educational & professional value added.

(value added to future scientists/engineers as opposed to products)

This process is as complex as the environments, the subjects, and the related levels of learning or of inquiries. Diagrams of a problem solving paradigm and of the scientific method illustrate the intricacies of *these processes that are generally cumulative, non-linear, and at time taxonomic.*

D. Human experiences through the ages and through different cultures.

This is an assignment for the reader! Hints: biographies, implicit learning, the reader's own experiences. The mode of transmission of "science and technology" before the advent of formal schooling generally included mentoring (apprenticeship, hands-on, and experiential learning).

E. The concept of distributed responsibilities and shared credits.

This concept is rooted in that of ultimate value: various parts of the core of a system could have vastly different prices even though the ultimate value of each of them is that of the properly operating system (i.e., cars, computers, etc.). In a situation of distributed responsibilities and shared credits, a problem is that individuals, groups, organizations, etc. could conveniently blame everything on others without taking stock into what exactly they have done lately! For mentoring, the responsibilities are distributed between the individuals (faculty, students, center directors, junior scientists/engineers, etc.), the department, the college, the research group, the research center, the research laboratory, the institution/organization, ... the funding agencies, the

policy makers. Responsibilities are distributed and credits are shared. To understand this in a profound fashion is to begin good practices of holistic and systemic mentoring (see the power law) for the training of the next generation of productive citizen, managers, research scholars, etc.

F. The synthesis of behaviorism and cognitivism.

This synthesis ends, once and for all, the debate over a "superiority" of one over the other. It turns out that "habit" and "memory" systems are both essentially relevant in learning. This synthesis actually dictates that both be appropriately activated by the optimum learning environments and situations. So, this synthesis profoundly supports experiential, hands-on, contextual, and relevant learning environments and processes advocated by the national educational reform blue-prints (including Shaping the Future for college teaching reform).

APPLICATION: A ROADMAP FOR REPLICATING THE TIMBUKTU ACADEMY

A distinction of the Timbuktu Academy resides in our attempt, so far successful, to apply the rigor and professionalism of research to the process of training and mentoring future researchers. Consequently, the programs and activities of the Academy are designed to adhere firmly to its paradigm. The genesis and evolution of this paradigm illustrates the synthesis of cognitivism and behaviorism. The reader is urged to consult the web site of the Academy, at <http://www.phys.subr.edu/timbuktu>, for extensive details on (a) our programs, (b) activities, (c) results (in terms of new knowledge and high quality scholars), and (d) funding sources. *The reader is urged to see the ten (10) activities of the Undergraduate Research Program (URP) that are keyed to the Paradigm.*

In particular, the diagrammatic representation of the paradigm of the Timbuktu Academy, the above annotations of the diagram, and the translation of these two into specific activities for pre-college, undergraduate, and graduate students clearly describe a comprehensive **roadmap for replication** in a home, at a school, in a college department, in a graduate school, and in public and private organizations! The activities always address the cognitive and non-cognitive (behavior, character, habits, etc.) variables—directly or indirectly. As such, they address the written and “unwritten” curricula which are inextricably linked.

ANNOTATED BIBLIOGRAPHY (REFERENCES)

- 1. "The Dynamics of Student Retention, a Review and a Prescription,"** D. Bagayoko and Ella L. Kelley. Education, Vol. 115, No. 1, pp. 31-39, Fall, 1994. This publication explains the process of creating educational value added, from K through graduate school and beyond, and the compound or integrated law of human performance.
- 2. "Cognitive Condensation for Mastery Teaching and Learning,"** D. Bagayoko and Ella L. Kelley. Education, Vol. 115, No. 1, pp. 18-25, Fall, 1994. This is a blue-print for mastery teaching and learning, in a age of information explosion. Understanding and knowing key anchors are preferred to memorizing a plethora of disjointed minutia.

3. **"Mentoring for the 21st Century,"** Proceedings, US Presidential Awards for the Excellence in Science, Mathematics, and Engineering, Washington, D.C., September, 1996. National Science Foundation publication number: NSF 97-124, (1997). This book contains extensive insights on various forms of mentoring: in museum, for K-12th grade students, for college students, in some research 1 and top ranked universities, and in some leading research organizations.
4. **"Mentoring, a Strategy for Increasing Minority Participation,"** D. Bagayoko. Proceedings, national conference on the role of social and behavioral science (SBS) careers in the 21st century, Radisson Hotel, New Orleans, Louisiana. April, 1997. Editor: Dr. Emmanuel Osagie at osagie@concentric.net. This paper is perhaps the one addressing most of the aspects of mentoring as noted in this presentation.
5. **"Behaviorism, Cognitivism and the Neuropsychology of Memory,"** Herbert L. Petri and Mortimer Mishkin. American Scientist, Vol. 82, pp. 30-37, 1994. This article ends the debate over "cognitivism versus behaviorism" as they apply to learning.
6. **"Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology,"** a report of the Advisory Committee to the National Science Foundation's Directorate for Education and Human Resources. National Science Foundation publication number: NSF 96-141, (1996). This blueprint actually applies, from its beginning to the end, the concept of "distributed responsibilities and shared credits" to the process of undergraduate education. Specifically, it spells out the role of everyone, from faculty members to funding agencies and policy makers!
7. **"The Timbuktu Academy,"** D. Bagayoko. (<http://www.phys.subr.edu/Timbuktu.htm>).
8. **"Aptitude Revisited: Rethinking Math and Science Education for America's Next Century,"** David E. Drew. Publisher: The John Hopkins University Press, 1996. This book shows that teaching and learning occur in a cultural context that is much relevant to these processes.

LIST OF ACTIVITIES BEARING ON MENTORING

Systemic Mentoring at the Timbuktu Academy

(The formula for student retention, on-time graduation, quality enhancement, the development of professionalism, and the gateway to graduate school and to competitiveness)

The following listing of the 10-step model of systemic mentoring activities of the Timbuktu Academy, and of the replication of the model through the Louis Stokes Louisiana Alliance for Minority Participation (LS-LAMP), is for the undergraduate level. The same ten (10) steps are applied in the seven (7) pre-college programs of the Academy, with slightly lighter emphasis on items 1 and 6 and with item No. 10 adapted to address the transition from high school to college SMET programs. All ten (10) steps are applied at the graduate school level as well.

As explained in the literature (Education, Vol. 115, No. 1, pp. 31-39, 1994), systemic mentoring is the **coupling** between *quality teaching and quality learning* on one hand, and between *quality teaching and quality research* on the other. Student retention, on-time graduation, and attendance and success in graduate school, according to the integrated law of human performance, are not “magical events.” They are natural consequences of exposure to the proper content and skill, in the proper sequence, at the adequate scope and depth, in a fashion that guarantees adequate practice—including research participation, as shown in the aforementioned article. Consequently, systemic mentoring, woven into the instructional, research, and service fabric of departments and units, is the hallmark of the Timbuktu Academy (<http://www.phys.subr.edu/timbuktu.htm>). We summarize below the ten (10) commandments of the *systemic mentoring model of the Timbuktu Academy at the undergraduate level*, as per its brochure that is available at the noted web site. **These activities are keyed to the paradigm of the Timbuktu Academy.**

1. Financial Support is provided to the scholars from *a variety of sources* – The remaining 9 steps of our research-based systemic mentoring model guarantee the use of the resulting *“time dividend”* for studying, research, and related enrichment activities on a full time basis—as opposed to frying ducks or indulging in relaxation unlimited. *According to the law of performance in the Paradigm of the Academy, adequate “time on tasks” is needed to cultivate academic or behavioral excellence!* Continued support from the Academy, for a scholar, requires full time “studying and research” during the academic year. The diversified funding base for the scholars include support from the Department of the Navy, Office of Naval Research (ONR), NASA, the Louisiana Tuition Opportunity Program for Students (TOPS), the National Science Foundation (NSF, through LS-LAMP), the Federal Student Financial Aid, and other scholarship and fellowship sources, including unit and institutional funds. A key to the Timbuktu Academy’s success for more than 10 years partly resides in the *diversified funding base*. (From the dawn of humanity to present, group, tribal, or public investment in an individual has been predicated on that person making or preparing to make positive contributions.) The list of the more than sixty (60), currently supported, undergraduate scholars is provided in the attachment. So is the list of

previously supported undergraduates along with the graduate school they attended or the gainful employment they secured, mostly in high technology industries.

2. Communication Skills Enhancement - A host of listening, speaking, reading, writing and related activities are aimed at developing the mastery of the applicable language (English), a vehicle of thought. The primacy of languages, in the Academy's Paradigm, dictates unrelenting attention to this enhancement. So do the rather low, national averages of many minority students on the verbal sections of the PSAT, SAT, ACT, and GRE. This activity includes vigorous exposure to technical communication as provided for in "*Writing for Success*" (1998, McGraw-Hill Companies, pp. 135-176 and pp. 212-215). We provide in the attachment a detailed, year by year listing of national and other conferences attended by the scholars. Extensive research reports and seminar and conference presentations are in the portfolio of each undergraduate scholar—to monitor properly our adherence to this critical step in the cultivation of academic excellence.

3. Comprehensive, Scientific Advisement - The proper sequencing of courses is treated with the utmost care. Indeed, the internal rigidity (or taxonomic structure) of science, engineering, mathematics, and technology (SMET) disciplines requires this approach. Empowering the learner is a central aim of mentoring. This empowerment includes grasping the power law of performance $[(T=A+B(N+E)^{-P})]$ and its extension, the integrated law of human performance (ILP); understanding and applying cognitive condensation for meta- and mastery-learning; and knowing a few time-tested quotes like the Jaime Escalante Equation (Determination + discipline + hard work = equal success). The Uri Treisman discovery in calculus, at Berkeley, is an indirect support of the power law of performance (the degree of alertness and of practice is expected to be higher in a group or cooperative learning environment). Naturally, regularly, advisement meetings with the Academy personnel are mandatory.

4. Tutoring - Tutoring by faculty members and particularly by peers will continue to be available to the students or scholars who need it. (In fact, regular tutoring areas are often taken over by self-organized study groups!) Tutoring is for excellence, not for remediation; it is to address holes in a background and to reinforce known essentials; to need tutoring is not a sign of any lack of intrinsic smartness, so says the power law of human performance, but rather a wise recognition of the internal rigidity of SMET fields. Incidentally, tutoring by scholars also promotes their communications skills and sense of self-worth while they review materials (so says the law of performance in the Paradigm of the Timbuktu Academy)!

.5. Generic Research Activities - Rigorous literature searches are conducted by the scholars on several subjects. They master sophisticated search algorithms, electronic searches, and related iterations. The scientific literature is an unlimited source of research questions! Refereed literature is the standard for SMET disciplines. Current awareness readings are part of these generic research activities—to follow developments as they occur. So is the development of communication (WRITING) skills germane to research. (Literature search reports and reports on special lectures or seminars are in the portfolios of the scholars.) As per the Paradigm of the Timbuktu Academy, to develop expertise or proficiency in a complex process requires practice.

6. Specific Research Project Execution by the scholars of the Timbuktu Academy-Faculty members and researchers at Federal and industrial laboratories serve as research supervisors and mentors to scholars, year round. According to the integrated law of human performance or the law of performance in the Academy's Paradigm, research experiences should prepare for graduate studies and for productive research careers. Seeking summer research opportunities on-line, at conferences, and through visits to various laboratories and agencies is one requirement for a systemic mentoring program. So says the category of "Distributed Responsibilities and Shared Credits" in the Paradigm of the Academy. (There is little credit in duplicating research facilities that, and personnel who, are readily available and accessible elsewhere.) Assisting scholars to apply vigorously and professionally for these opportunities and maintaining adequate files on each scholar, partly for the purpose of writing *substantial* (as opposed to general and vague) *recommendations*, are some tasks for mentors to accomplish.

Summer Research by Scholars	1994	1995	1996	1997	1998	1999	2000	2001
Number of Students Placed	18	21	28	40	43	47	39	--
Number of Research Sites	6	12	20	32	33	32	22	--

-- Data not yet finalized (as of 4/20/01)

7. Development of or Immersion in a Professional Culture - Every scholar is exposed to discussions that explore the dimensions of *ethics in science*. Immersion in a professional culture demands a regular reading of technical journals and appropriate magazines of professional societies, conference attendance, and collaboration with others. Current awareness needs no explanation in an era of information explosion. Professional practices and standards are set and seen in publications, *seminars*, and at conferences. As for the need for and value of collaboration, we simply assert that not one individual has built or operated a nuclear submarine, an aircraft carrier, or a space shuttle alone! The following, specific subcomponents of this step directly address the two summative variables identified by quantitative student-retention models (i.e., those of Tinto, Beans, and Cabrera, respectively): Academic Integration and Social Integration.

The Weekly Seminars play a crucial role in the development of a professional culture. They repeatedly emphasize the need for superior academic performance and provide a clear road map for any student to make a genius out of himself/herself. Topics that are discussed include "*The Integrated Law of Human Performance*," "*How to Study Successfully*," "*Problem-solving Proficiency by Design*," "*The Scientific Method in Practice*," "*Ethics in SMET*," "*Thought, Emotion, and Action Management (TEAM)*," a host of *technical research topics*, and the quintessential importance of communication skills. At the weekly seminars, presentations are made by eminent guest speakers, faculty, and Timbuktu Academy scholars and personnel. These seminars are mandatory. (See weekly seminars in graduate departments and research centers!)

Participation in local, state and national conferences is critical part of the immersion into a professional culture. They address horizon-broadening, networking, keeping current, etc. As per the table below, tens of Academy scholars attend regional and national conferences each year (i.e., 65, 97, and 89 respectively in 1999, 2000, and 2001; the last one is as of 4/20/01). In addition to the reasons given above, please recall, conferences are celebrations of scholarship as explained below!

Conference Participation	1994	1995	1996	1997	1998	1999	2000	2001**
Number of conferences	5	8	10	9	5	6	5	6
Number of students attending	58	34	126	67	11	65	97	89
Number of students presenting	12	5	9	14	0	1	3	16

** As of 4/20/2001

Implicitly and Explicitly Valuing Scholarship -a A particular event in this pervasive valuing process consists of **the Annual Summer Pre-College Quiz Bowl** and participation in the **National Honda Quiz Bowl**. In 2000, the SUBR team that placed No. 2 in the nation included a scholar of the Timbuktu Academy (Philip Jones). The importance of a quiz bowl resides in the *celebration of academic excellence*, intellectual prowess and the promotion of scholarship as an integral part of the professional value system. (Families, schools, universities, and countries with extensive and regular sporting events—with the accompanying celebrity status of the athletes—should understand, in the absence of one (or more) regular event that publicly values of celebrates intellectual achievements, that they are downgrading or devaluing intellectual accomplishments implicitly, by default, or by comparison!) Incidentally, the limited public focus in seminars, conferences, etc. subtly serve to value scholarship! This statement applies to the Academy's weekly seminars!

8. Development or Enhancement of Computer and Technological Skills - The mastery of productivity tools, including word-processing, spreadsheets, database, graphics, other applications, and scientific programming (C++, FORTRAN, etc.) are needed. Advanced exposure has to include a programming language. (The need for these activities is given by the environments to which the students are destined, i.e., graduate schools and the global market). Given the primacy of languages as vehicles of thought (i.e., paradigm of the Timbuktu Academy), efforts are devoted, *year-around*, to the development or enhancement of communication skills (including technical writing).

9. Monitoring - With monitoring, throughout the semester, potential problems are avoided before they become permanent Fs. Preventive measures include concentrated efforts, extra-tutoring, and the last resort, dropping a course. The former two steps are best when they are taken as early as possible. The latter step is not an available option past a certain date after mid-term! The monitoring of research participation and performance is critical for another reason: *the development or reinforcement of non-cognitive skills that undergird success (self-discipline, hard work, assiduity, ethical conduct, working well with others, etc.)*. Monitoring and evaluation are part of a professional environment, without them, who will know what a beautiful job a scholar has done! An individual Mentoring Portfolio is maintained for every one of the 60 - 100 scholars and affiliate scholars (no supported financially by the Academy) for the duration of their studies and beyond! (We determined that every family, to take parenting to the next level, should maintain a parenting portfolio on every child!)

10. Guidance to Graduate School - **It begins in the freshman year** (or earlier) and includes research experiences, conference attendance, *GRE preparation* starting the freshman year, and opportunities for financial support for graduate studies. Placement in graduate programs follows steps similar to those for summer placement. The number and the extent of the opportunities depend on the cumulative grade point average for the BS degree, the courses taken,

research experiences and results, and the GRE score. These measures of preparedness for graduate studies are also indicators of self-discipline, focus, the quality and scope of exposure to subject content, and research skills. They are, hence, indicators of the likelihood that a prospective graduate student will pass the required courses and will make contributions in research! In addition, graduate preparation will include an understanding of the non-academic factors that are critical to success in graduate school. Emphasis will be placed on the establishment of a seamless transition to graduate school.

The rigorous reasons for the above detailed description of the components and activities of our systemic mentoring are implicitly in the Section above, i.e., our understanding of the issues. The continued implementation, expansion, and institutionalization of these activities, as they apply to minority students and others, are core activities of the Timbuktu Academy. *We should add the formal institutionalization of systemic mentoring in SMET departments (1997) and all departments (1998) at SUBR.*

It is important to note that these steps address all four (4) key transition or articulation points. The latter are high school to college SMET, college undecided to college SMET, community colleges to four-year college SMET and college SMET to graduate and Ph.D. programs in SMET. The working rationale that partly explains the success of the above model includes the fact that transition activities not coupled with systemic mentoring (structured organization) do not have lasting effects.

The above steps for systemic mentoring are rigorously applied from middle school to Graduate school, with obvious adjustments for the middle school. They are followed to the letter, as noted above, for undergraduates and graduate students. For high school students, instead of preparing for the GRE, we prepare for the ACT/SAT. We guide in the course taking needed for successful enrollment in Science, Mathematics, Engineering, and Technology (SMET) disciplines.

SUSTAINED ACHIEVEMENTS

OF THE TIMBUKTU ACADEMY IN MENTORING AND RELATED ACTIVITIES

SUMMARY ON GRADUATES/SCHOLARS AND OTHER ACHIEVEMENTS

SMET MINORITY GRADUATES AND PRE-COLLEGE SCHOLARS

PRODUCTION OF MASTER'S DEGREE HOLDERS IN PHYSICS: Titles of Theses, Names of Graduate students, and Graduation Dates

[The newly established graduate component of the Academy (GREAT, 1996) is limited to Physics majors, for the moment]

"The BZW Method and the Electronic Properties of Zinc Selenide (ZnSe)." Graduate Student: LaShounda Torrence. Successful Defense in October 2000. Graduate Date: May 2001.

"Optimization Studies of Polymer Electrolyte Fuel Cell Performance in the Presence of Reformate Gas in the Anode Feedstream." Graduate Student: Mr. Tommy Q. T. Rockward. Date of Graduation: December 15, 1998.

"The Electronic Structure and Optical Properties of Ruthenium Dioxide." Graduate Student: Mr. Troy. D. Williams. Date of graduation: July 31, 1998.

"The Electronic, Magnetic, and Structural Properties of $Al_{18}Fe$." Graduate Student: Ms. LaKindra P. Francis. Date of Graduation: July 31, 1998.

PRODUCTION OF BS DEGREE HOLDERS (Physics, Chemistry, and Engineering) WHO ATTEND AND SUCCEED IN GRADUATE SCHOOL (106 graduates as of July 2001)

As of the fall of 2000, ninety eight (98) Academy scholars have earned bachelor degrees: 58 in Physics, 18 in Chemistry, and 22 in Engineering. Seven (7) and one (1) scholars are expected (as per graduation clearance review) to graduate in May 2001 and July 2001, respectively. These numbers show that our key objective, relative to the production of graduates, has been met and surpassed. Seventy-eight percent (78%) of Physics scholars have successfully enrolled in

graduate school. Our graduate school attendance rates are 50% for Chemistry and around 32% for Engineering. The National average for graduate school enrollment of Physics BS holders is 52-60% as per the annual, enrollment reports of the American Institute of Physics (AIP).

**African American SMET Graduates Mentored in the Timbuktu Academy
And Numbers Who Completed or Are in Graduate School**

Description	1994	1995	1996	1997	1998	1999	2000	Total
PHYSICS MAJORS	12*	6	10	8	10	8	4	58
Enrolled/completed grad. school	11	3	5	7	7	6	1	40
Gainfully employed -began grad.	0	0	3	0	1	0	0	4
Gainfully employed	1	3	2	1	2	1	2	12
In transition	0	0	0	0	0	1	1	2
CHEMISTRY MAJORS	--	--	3	2	6	5	2	18
Enrolled/completed grad. school	--	--	2	0	5	2	0	9
Gainfully employed -began grad.	--	--	0	0	0	0	0	0
Gainfully employed	--	--	1	1	1	3	2	8
In transition	--	--	0	1	0	0	0	1
ENGINEERING MAJORS	2	1	1	2	5	7	4	22
Enrolled/completed grad. school	0	0	0	1	3	2	1	7
Gainfully employed & grad. scho.	0	0	0	0	0	0	0	0
Gainfully employed	2	1	1	1	2	5	2	14
In transition	0	0	0	0	0	0	1	1

**Includes 1992 and 1993 graduates*

-- Not Applicable, Chemistry students were admitted into the Academy starting in 1993-94.

PRODUCTION OF PRE-COLLEGE SCHOLARS (WHO ENROLL MOSTLY IN COLLEGE SMET CURRICULA): Over 800 from 1996 to 2000

The systematic approach of the Timbuktu Academy to addressing the pipeline in science, mathematics, engineering, and technology (SMET) explains the reasons that its seven (7) programs for pre-college students are critically important. The paradigm of the Academy clearly explains that students who have not be appropriately exposed to standard -based and challenging curricula, irrespective of their ethnicity, gender, and socioeconomic backgrounds are likely (a) to underachieve (see PSAT and ACT to GRE scores) and (b) to be ill -equipped for SMET curricula in college. The table below tells the story. **Over 800 students have been mentored from 1996 to 2000 (i.e., last 5 years).** About 25% of the elementary to 9th grade students participate for more than a year; hence, the 800 number above stands for about 600 distinct individuals.

Program	1994	1995	1996	1997	1998	1999	2000
Getting Smart at the Timbuktu Academy	--	--	--	--	--	--	20

(GeSTA)							
Summer Science Institute - Middle School Component (SSI -M)	39	40	80	80	70	60	63
Summer Enrichment at the Timbuktu Academy (SETA)	0	0	0	24	22	18	27
Summer Science Institute (SSI)	40	53	39	23	21	19	20
Challenge 2000 at the Timbuktu Academy (Challenge 2000)	--	--	--	20	19	22	23
Earth Science at the Timbuktu Academy (ESTA)	--	--	--	--	--	28	21
Summer Bridge Institute (SBI)	25	25	24	13	14	13	19

The average increase in ACT scores, as attributable only to the summer programs, ranged from 2.5 to 3.0 points from the summer of 1994 to the summer of 1997. (ACT/SAT scores are required immediately before and immediately after the participation in SSI, Challenge, and ESTA!) Building upon our acquired expertise in creating educational value-added, we made appropriate changes to the 1998 summer programs and increased the English practice time. For that summer (1998), we had increases in the ACT English and composite score of five (5) and four (4) points, respectively. *These quantum leaps were directed caused, for the most part, by the six-week, residential, academic enrichment program of the Timbuktu Academy (i.e., for high school students in SSI and Challenge 2000).*

PRODUCTION OF NATIONAL ACHIEVEMENT/NATIONAL MERIT SCHOLARS

(From the pool of tenth graders in the above programs, in the summer of 1999 and 2000)

In each of 1999 and 2000, the Academy produced ten (10) National Achievement and three (3) National Merit Scholars; all the ten students scored at or above the 93 percentile nationwide, in 1999, with some at the 99 percentile! The ten (10) scholars of 2000 performed similarly—by design.

OTHER ACCOMPLISHMENTS

PRODUCTION AND DISSEMINATION OF NEW KNOWLEDGE ON MENTORING

- *We placed the creation of educational value added on a rigorous, scientific basis by understanding, extending, and applying the power law of human performance to totally explain how to "avoid or close academic achievement gaps" from pre-K through graduate school and beyond. Proceedings, DOE-EPSCoR/LS-LAMP Annual Conference, February 2001. (Related paper and viewgraphs are available at the web site of the Academy (<http://www.phys.subr.edu/timbuktu.htm>).*
- *We introduced the Bagayoko, Zhao, and Williams (BZW) procedure in ab-initio calculations and ushered in the era of predictive computations of excitation-related*

properties of atoms, molecules, clusters, semiconductors, and insulators (Bulletin, American Physical Society, Vol. 43, No. 1, p. 846, 1998; Journal of Physics: Condensed Matter, Vol. 10, No. 25, pp. 5645-5655, 1998; and Physical Review B60, pp. 1563-1572, 1999). While these seminal publications are not on mentoring, their relevance resides in the provision of an internationally competitive research productivity is physics--as a model for the scholars to emulate In their respective SMET fields!

Over the last five years, the Academy personnel authored or co-authored over fifteen (15) scholarly publications on the creation of educational value-added and on mentoring and more than thirty (30) technical publications mostly in condensed matter physics. *Over the last five years, the Academy personnel made over sixty five (65) presentations, thirty (30) of which were devoted to mentoring and twenty (20) were national.*

Selected Publications on Teaching, Mentoring, and Learning (TML)--by the *Timbuktu Academy* personnel. The Academy and its funding sources are explicitly acknowledged in these publications.

15. *"The Timbuktu Academy: Paradigm, Program Components, Activities, and Results."*
Available on the web (<http://www.phys.subr.edu/timbuktu.htm>)
14. *"A Rosetta Stone for Competitive Education."* A thirty minute video that utilizes the current sum of knowledge in education, cognition, behaviorism, etc. to decipher the process of acquiring a competitive education in a way analogous to the use of the Rosetta stone to decipher the Egyptian hieroglyphics.
13. *"The Genesis of Genius,"* a one hour video on explaining the creation of educational value-added from pre-K through graduate school and beyond. Shown on Television, for a whole month, throughout the State of Louisiana.
12. *"Avoiding or Closing Academic Achievement Gaps."* D. Bagayoko, S. Hasan, and R. L. Ford, Proceedings, DOE-EPSCoR/Ls-LAMP Annual Conference, February 11-13, 2001, Radisson Hotel, New Orleans, Louisiana.
11. *"Fundamentals of Mentoring and Networking."* D. Bagayoko, Robert L. Ford, and Ella L. Kelley; a chapter in a monograph entitled "Scholarly Guideposts for Junior Faculty Members," Published by Quality Education for Minority (QEM) Network. Washington, D.C., February, 2000.
10. *"Perspective of a US Presidential Awardee on Workforce Development."* US Science, Engineering, and Technology Workforce of the Future: National Strategy, National Portfolio, National Resource Base. Publication Number: [NSF 99-132](#); pages 121-123 for D. Bagayoko's contribution.
09. *"A Problem Solving Paradigm,"* D. Bagayoko, Ella L. Kelley, and Saleem Hasan. College Teaching, Vol. 48, No. 1, 24-27, 2000.
08. *"Misconceptions and the Certainty of Response Index (CRI),"* Saleem Hasan, D. Bagayoko, and Ella L. Kelley. Physics Education (UK) 34 (5), pp. 294-299, 1999.

07. "Early Guidance Pays Off: Mentoring students in science, engineering and math promotes success." Diola Bagayoko, Resource Magazine, American Society of Agricultural Engineering , published by the National Congress for Community Economic Development (NCCED), Vol. 5, No. 4, page 29, 1998.
06. Co-author, with Professor Ora Plummer as the first author, of a 200 page writing book entitled "Writing for Success," Publisher: McGraw Hill, ISBN: 0-07-154196-9 (1998).
05. "The Dynamics of Student Retention," D. Bagayoko and Ella L. Kelley, Education Vol. 115, No.1, 31-39 (fall, 1994).
04. "Cognitive Condensation for Mastery Teaching and Learning," D. Bagayoko and E. L. Kelley, Education, Vol. 115, NO. 1, 19-25 (fall 1994).
03. "A Paradigm of Education: the Model of the Timbuktu Academy," W. E. Moore and D. Bagayoko, Education, Vol. 115, NO. 1, 11-18 (fall, 1994).
02. "The Maxwell's Thermodynamics Equations - A Simplified Aide Memoire," Physics Education, Vol. 27, No. 3, 128-129, 1992. Publisher: Institute of Physics, London.
01. "Mechanics" in Magill's Survey of Science: Physical Science, Publisher: Salem Press, Pasadena, California (Jan. 1992). ISBN: 0-89356-618-7, pp. 1367-1373, (Invited Chapter).

DELIVERY OF EDUCATIONAL SERVICES TO THE PRE-COLLEGE COMMUNITIES AND OTHERS

The Timbuktu Academy reaches over 5,000 pre-college and college students, teachers, parents and others, per year, as of 1994, with printed materials, motivational speeches, workshops, etc. The illustrative publications listed above, the more than 65 presentations in the last five years, and the new approach with television shows--the Academy has reached, in 2000, several time the above number. (The referenced TV shows reach 99% of Louisiana households.)

DEVELOPMENT SMET INFRASTRUCTURE AND RELATED RESULTS

- *A dramatic increase in the number and the quality of students.* The number of physics majors jumped from 23 in 1989-90, before the Academy, to well over 60, starting in 1995-96. The average American College Test (ACT) score of physics freshmen was around 20 before 1992. It jumped to 23 in 1993-94 and to 24-25 in 1996-97 and 1997-98. The average Graduate Record Examination (GRE) score of physics graduates has increased by 23.2% since the inception of the Academy and it continues to go up.
- *Impact on Student Retention Rate.* The University's average retention rate was 51.55% for the 1994-1998 time period. The Academy shares significantly in the credit for the far better retention rates in the departments or units affected by the Timbuktu Academy: Physics (83.33 %), Chemistry (67.74 %) and Mechanical Engineering (55.21 %). These rates are from the

ongoing, longitudinal, retention studies by the SUBR Office of Planning, Assessment, and Institutional Research at Southern University and A&M College

- *Impact on the Rating of the Physics Program.* A 1994 report of national experts hired by the Louisiana Board of Regents stated: “*The undergraduate physics program at SUBR is among the best we have encountered anywhere...The vehicle for this has been the altogether remarkable organization, the Timbuktu Academy.*” The establishment of the MS degree program in the fall of 1996 was made possible by the above increased enrollment at the undergraduate level and the high quality of the scholars.
- *Institution-wide and Statewide Replication of the Timbuktu Academy through the Louis Stokes Louisiana Alliance for Minority Participation (LS-LAMP).* As per the reports from the National Science Foundation’s reviewers, the funding of the Louis Stokes Louisiana Alliance for Minority Participation (LS-LAMP) in 1995 was strongly based on the holistic, systemic mentoring model of the Timbuktu Academy. LS-LAMP is partly replicating the model of the Academy in eleven (11) higher education institutions, including SUBR, the lead - institution for the LS-LAMP Consortium. SUBR, as the lead, decided to lead the nation by (a) establishing formal, systemic mentoring in all its SMET departments in January 1997. It provided a quarter release time (using its own funds) for a mentoring coordinator per department. Efforts are underway to extend the implementation to all departments (as formally approved by the Council of Deans in the spring of 1998). *For the Timbuktu Academy, the issue is not one of potential for replication: its successful replication has been ongoing since 1996; the renewal funding of LS-LAMP by the National Science Foundation (NSF) in 2000, for five more years, partly supports this contention.*
- *Replication at the Graduate Level.* While not directly supported by ONR or NSF, the establishment of the graduate component of the Timbuktu Academy (funded by the Louisiana Board of Regents) was based on the success of the undergraduate component, as per the report of national experts consulted by the Louisiana Board of Regents. *Graduate Research Excellence at the Timbuktu Academy (GREAT)* is a superior graduate fellowship program that has supported six (6) minority graduate scholars to date. Six more are to be supported starting in the fall of 2001!
- *Linkages/Partnerships/Collaborations.* From the inception of the Academy to present, we have continued to expand our partnerships with federal, university, and industrial research laboratories. In particular, in the summers of 1996, 1997, 1998, 1999, and 2000 we respectively placed 28, 40, 43, 48, and 39 Academy scholars at research sites across the country. The costs for the travel and stipends of these scholar -interns were borne by the host institutions. *For an average of \$5,000 per student, the resulting supplemental support amounted to \$140,000, \$200,000, \$215,000, \$255,000, and 195,000 for 1996, 1997, 1998, 1999, and 2000, respectively. The listing of the scholars and of their research sites, for each of the summers of 1996 to 2000, is provided in the attachment.*

We believe, at the Timbuktu Academy, that we have to operate in the national context; as such, *linkages, partnerships, collaborations* with national, university, and industrial

laboratories and research organizations is simply a "prime directive." This is not only to ensure the access of the scholars to the best, but also to widen their horizons and professional networks beyond what exists on a single campus (i.e., SUBR) --while avoiding unnecessary duplication.

Naturally, the above points mean, in light of the "distributed responsibilities and shared credits" concept introduced by the Academy, that the results of the Timbuktu Academy are partly and significantly shared by these partner organizations whose names can be found in the listing of summer research sites and on the web page of the Academy.

EXTERNAL RECOGNITION (A key recognition for the Timbuktu Academy is that which is earned by hundreds of its college and precollege scholars)

- ◆ In 1996, the Timbuktu Academy received the Quality Education for Minority (QEM) Network's *National Exemplary Mathematics, Science and Engineering Undergraduate Program Award*.
- ◆ Undergraduate scholars of the Timbuktu Academy have won more prizes (1st, 2nd, and 3rd) for presentations, awards for summer internships, and prestigious scholarships, and graduate fellowships/assistantships than we have space to list!. *The listing of the competitive summer research awards is the same as that on the summer research sites; it takes five pages for the last five years. (It is provided in the attachment.)*
- ◆ The Timbuktu Academy scholars (from middle school to graduate school) have won more scholastic awards, undergraduate scholarships, graduate fellowships, etc. than we have space to list. Please see the detailed listed of the alumni of the Academy and of the graduate schools many of them are attending; this list illustrates the list of graduate assistantships and fellowships the scholars have won. As for the National Merit and National Achievement scholars the Academy helped to produced (10 in 1999 and 10 in 2000), each one of them literally received over one hundred (100) offers of scholarships/fellowships.

PLEASE SEE APPENDICES PROVIDED AS SEPARATE LINKS

They address

- **The Paradigm, Program Components, Activities, and Results of the Academy**
- **The 10-Step Systemic Mentoring Model of the Timbuktu Academy & Conference Participation**
- **The List of Minority SMET Graduates and Their Graduate School Attendance**
- **A Typical Daily Schedule of the Summer, Residential, Pre-college Components of the Timbuktu Academy (SSI, Challenge 2000, and ESTA)**
- **The List of the Pre-college Scholars of the Timbuktu Academy**
- **The National Merit and National Achievement Scholars Produced by the Academy**
- **Summer Research Sites of the Undergraduate Scholars of the Timbuktu Academy**